DEPARTMENT OF
PRIMARY INDUSTRIES

Turning Grain into Gold

Student Activity Sheets

Victoria
The Place To Be

Turning Grain into Gold
Student Activity Sheets

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1 Treasury Place, East Melbourne, Victoria 3002 Australia

Further information regarding grains contact the DPI Horsham Centre
Telephone: +03 5362 2111 Facsimile: +035362 2187
Find more information about DPI on the internet at: http://www.dpi.vic.gov.au or contact the DPI Customer Service Centre on 136 186

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Turning Grain into Gold

Student Activity Sheets

Contents

Student Activity 1

Where do you get your food from?

Have you ever wondered where our food comes from? In Australia lots of people eat many different types of foods.

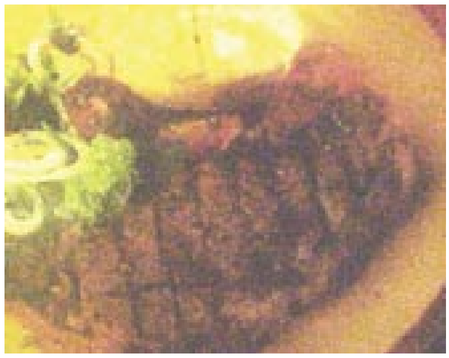
Cake

Vegetable soup

Chicken, salad and rice

Vegetarian roll-ups

Hamburgers



Steak, potato and salad

Things to do

1. Showcase the different foods you have eaten over the last week. You may do this by writing a list, or by making a collage of pictures of foods from magazine articles and advertisements, or by bringing samples to class and making a presentation.
2. Think carefully about the different foods you ate and estimate what proportion of the food is from plants, and what comes from animals.

   (There are a few extra things to consider. Meat may have been coated or stuffed with flour (batter) or breadcrumbs, and cooked in vegetable oil. Soya beans may have been used instead of canned meat or meatloaf. It may not be easy to estimate amounts because meats may weigh more than the same amount (volume) of food from plants. Remember that 50% is half, 33% is a third, 25% is a quarter, 20% is a fifth, if you want to estimate in percentage).
3. Compare your answers with others in the class and decide whether we get most of our food from plants, or from animals.

Extensions

1. Compare the food you eat with the diet of people in another country such as India or China. Which country eats more plants in their food? Why do you think this happens?
2. Collect information about the types of food that different animals eat. Which animals eat food only from plants, which eat mostly plants and which animals eat food mostly from other animals.
3. Draw a food web showing the relationships between the food you eat and yourself.

Resources

Food or popular magazines, library book search, or Internet search.

Name ....

☐	Food from grains	Percentage for the week = %
☐	Food from meat	Percentage for the week = %
☐	Food from vegetables & fruit	Percentage for the week = %

Student Activity 2

What is the food value of different foods?

We name different food types because of the chemical structures they contain, and we call them carbohydrates, proteins, lipids, vitamins, minerals and fibre.

We eat <u>carbohydrates</u> mainly for energy, <u>proteins</u> are important for growth and body processes as well as energy, and <u>lipids</u> (fats & oils) are mainly for energy and for some body processes. <u>Vitamins</u> and <u>minerals</u> are important in small amounts for body processes and growth and <u>fibre</u> is important for the health of our digestive system.

Different foods have varying values as food because they contain different amounts of each food type.

Experiment - Comparing the food value contained in different foods.

For this experiment you will be using some chemicals that can stain or react with your clothes or skin, so you need to wear a labcoat and use safety glasses.

1a. Using the appropriate food tests in part c below, test control (known) samples of each of the food types (carbohydrates, proteins, lipids, etc) to find the expected colour changes for each reaction.

1b. Collect a range of different foods including bread, breakfast cereals, fruits, meat, cheese, desserts, etc

1c. Test each food separately by getting a small pea-sized sample of the food, crushing it up and mixing it with about 10 ml of water to make a liquid sample. Pour 1 to 2ml of this liquid sample into 6 clean test tubes, then test these samples for the presence of:

- **carbohydrate** (starch), using drops of iodine-potassium iodide solution;
- **carbohydrate (**glucose), using some (5 to 10 mL) Benedict's reagent and heating gently in a water bath;
- **protein,** using Sakaguchi test (1 mL of sodium hydroxide, 2 drops of naphthol solution, and 1 drop of **fresh** bleach) **(be careful, sodium hydroxide dissolves skin**);
- **oil** or **fat,** using drops of Sudan IV stain **(be careful, it stains)**;
- **vitamin C,** by adding drops of the food sample into the DCPIP solution (or by using the starch/iodine test);
- sodium chloride (**salt),** using drops of silver chloride solution **(be careful, it stains).**

1d. Record your results in a table.

1e. Which foods (plant or animal) contained most carbohydrate (starch and sugar)? Most protein? Most fat/oil? Most vitamin C? Most salt?

1f. From the foods you tested, decide which food type had most food value (say why), and compare this with the food type you would like to eat most (say why).

Extension

1. Collect nutrition and ingredients information from food containers to show the different food values of various foods. Stick this information on your page.
2. From these different foods select a menu for one day to give you best nutrition.
3. Did your most important foods come from animals or plants? Explain.
4. Design your own experiment to compare different foods – e.g. compare the amounts of Vitamin C in different types of orange drinks, or amounts of sugar or salt in foods.

Nutrition Facts

Serving Size 1/2 cup (114g)
Servings Per Container 4

Amount Per Serving		
Calories 90	Calories from Fat 30	
	% Daily Value*	
Total Fat 3g	5%	
Saturated Fat 0g	0%	
Cholesterol 0mg	0%	
Sodium 300mg	13%	
Total Carbohydrate 13g	4%	
Dietary Fibre 3g	12%	
Sugars 3g		
Protein 3g		
Vitamin A 80%	*	Vitamin C 60%
Calcium 4%	*	Iron 10%

Student Activity 3

Comparing different grains – physically

The word 'grains' usually applies to seeds of cereals of the grass family Gramineae, like wheat, rice, barley, oats, maize (corn), rye and triticale. There are now many types of crops grown in Australia for their seeds including lentils, peas, beans and lupins (legume family, also called 'pulses'), oilseeds such as canola (mustard family), safflower and sunflower (daisy family).

Experiment

Collect a range of different seeds such as those listed above.

1a. 'Plant' different types of seed on paper or cottonwool in dishes and keep them moist.

1b. Examine the seedlings from the germinating seeds after 1 week. Dicotyledonous plants (dicots) produce 2 'seed-leaves' (first leaves that may still look like parts of the seed) while monocotyledonous plants (monocots) have a single first leaf. Make a drawing of 1 seedling from each of the plant types to show the differences. Label the drawings with the names of the plants, and decide if they are monocots or dicots.

2a. Soak different types of seeds to make them soft (before class). Cut the soaked seeds in half longitudinally down the midline (using a 1-sided razor blade) and find the different structures of seedcoat, food store (endosperm) and plant embryo (germ). Dicotyledonous seeds split into 2 parts and often have a large embryo with partly formed root (radicle). Monocot seeds do not split easily into 2 parts.

2b. Draw each type of dissected seed, labelling the parts. Decide if they are monocots or dicots, and compare your results with those from part 1b above.

Extension

1. Test the different seeds with the food tests from the Student Activity 2 – for starch, sugar (glucose), protein and fat/oil. You may also find peanuts worth testing.
2. Different types of seeds usually have different food values. Generally cereal grains are grown for their starch content to make flour, legumes contain more protein, and oilseeds contain enough oil as their food store for it to be extracted for commercial use.
    a. Compare your results with those expected from this information.
    b. Decide which seed would supply the greatest range of nutrients.
3. Compare different sizes of seed. Is it better to eat food from lots of small seeds or fewer large seeds, or a mixture of seeds? Why?

Student Activity 4

Comparing different grains – socially and economically

Different grains are preferred in different parts of the world, and in different parts of Australia. This may be due to differences in climate and soil type, which affect the types of plant that can be grown successfully, and also due to differences in which grains people prefer to use as food. Even on the same Australian farm different grains are grown in separate paddocks, and the grains that are used depend on income produced from each grain, the equipment and expertise available on the farm, and on the farmer's crop rotation program.

Things to do

1. For a grain farm in Victoria, find out and write down:
   a. the types of grains that have been grown on the farm, and why they were chosen;
   b. which other grains are being considered for the future, and why.
2. Make a list of **10** different types of grain grown in Australia, saying where in Australia they are grown.
3. For **1** of these grains write down (using class textbooks, library or the internet):
   a. the economic importance of the grain to the world;
   b. the economic importance of the grain to Australia;
   c. how much of the grain is produced each year in Australia.

Resources

www.dpi.vic.gov.au/web/root/Domino/vro/ is the site for Victorian Resources Online, which gives information about each region and the crops they grow.

www.dpi.vic.gov.au also has information on particular Victorian crops, and how they are grown and marketed. This includes access to Notes sheets on 'Growing Wheat', etc.

www.awb.com.au has a lot of information about wheat in Australia.

www.localdirectory.com.au can be used to find contact details for farmers and associated businesses. Also for the Wimmera you can use www.wimmera.yourguide.com.au or www.wimmera.com.au to find regional information and links to other sites.

www.dfat.gov.au/regionalexporters/ is the Australian Government Department of Trade site which gives information about exports from regions.

www.abs.gov.au the site for Australian Bureau of Statistics has information about Australia's economy and society and trends, but some information may need subscription.

www.agriculture.gov.au gives information on Australian 'Field and Fodder Crops'.
www.affa.gov.au also from Australian government has Industry Development pages on various grains, and also has links to other grains groups like Grains Research and Development Corporation, Wheat Export Authority, Australian Wheat Board, Pulse Australia, and Australian Oilseeds Federation.

www.abare.gov.au has information on Australian commodities, especially forecasts on production and income from various grains. Further information needs subscription.

Student Activity 5

Comparing uses of different grains

We often think of wheat as being the only grain that produces flour, but almost any grain that is ground or milled will produce a flour. So why is wheat so universal and the preferred grain?

What do we look for, when deciding what is a good food?

1. Make your own list of what you think makes a food 'good'.
2. Compare your list with others in the class and add ideas to your list if needed.
3. Discuss how you could measure what is a 'good' pancake. Develop a scoring system (say 1-5) and include categories like texture, flavour, colour, and aroma.
4. Now try making four different types of small pancakes (drop scones) using 4 different types of flour. Choose from wheat (white), wheat (wholemeal), triticale, besan (chickpea), cornflour, spelt (a type of wheat), barley, rice and oat flours.
5. Taste each pancake and score them with the system you developed.
6. Taste pancakes from other mixtures, then together with the whole class score all the different pancakes from best to worst. Write the results down, then say where you disagree with the class results, and why.

The Recipe

Ingredients

1 cup of flour

¾ to 1 cup of milk (runny mix with more milk makes flat pancakes)

1½ teaspoons baking powder

1 egg

Method

- Stir or sift together flour and baking powder.
- Beat egg and stir into flour, then stir in milk.
- Place dessertspoons of the batter in a hot, lightly greased griddle or heavy frying pan.
- Keep the pan at a steady heat, and when bubbles rise to the surface of the pancake and burst, turn the pancakes over. Continue cooking until brown on the other side, 4-6 minutes in all (smaller portions can cook quicker).
- Place the cooked pancakes on a clean towel, cover with another and place on a rack to cool. This keeps in the steam so that the pancakes do not become dry.

Student Activity 6

History and importance of wheat growing in the Wimmera

Wheat is the world's most important grain, with the largest area of all grain crops. It is the staple or main grain used by much of the world's population. Wheat has been used by man since prehistoric times. Now, almost everybody in Australia eats wheat in one of its many forms, every day.

Things to do

Using the Internet, class texts and library reference books, create a display or presentation which answers the questions below. The display may take the form of a poster, a PowerPoint slide show, a collage of written work and pictures, or any other form which your teacher approves.

Questions

1. What are the main areas where is wheat grown in Australia?
2. What are the main areas where wheat is grown in Victoria?
3. What is wheat actually, and where did it originally come from?
4. Where was wheat grown first in Australia, and how successful was it?
5. List 4 important factors causing the development of wheat growing in the Wimmera.
6. List 2 main factors that cause different amounts of wheat to be produced in the Wimmera from year to year.
7. What happens to most of the wheat grown in the Wimmera?
8. Name 4 different types of wheat and say what they can be used for.

References

Australian Wheat Board – www.awb.com.au/AWB/user/communityEducation/.

Victorian Department of Primary Industries- www.dpi.vic.gov.au.

Victorian Resources Online- www.dpi.vic.gov.au/web/root/Domino/vro/.

Australian agriculture- www.agriculture.gov.au for Australian 'Field and Fodder Crops'.

Year books, Manual of Australian Agriculture, Atlases, Australian encyclopaedias.

Student Activity 7

The wheat plant

Over its lifetime the wheat plant changes its appearance. It changes from seed, to seedling, to growing plant, to flowering plant, and eventually to mature plant with seeds. As it goes through this life-cycle, it also changes many of its functions.

Things to do

1. Obtain a ‘normal’ wheat grain. Using a magnifying glass, draw a labelled diagram of the grain (make the diagram large enough to distinguish the parts). Show where the seed was attached.
2. Cut a softened grain down the middle. Again with the magnifying glass, draw an enlarged labelled diagram of the insides of the grain, using the labels seedcoat, radicle, plumule, embryo and endosperm. Say why each of these parts is important to the seed.

   Name the parts of the seed that make bran, wheat germ, and flour.
3. Obtain a germinated wheat seedling, handling it very carefully. Draw an enlarged diagram, labelling the developing root with its root hairs, and coleoptile (shoot cover). Normally the seed is underground, the roots develop quickly, then the coleoptile pushes to the surface and the shoot (new leaf) pushes through the coleoptile. Say why you think the roots are so important, and why a coleoptile is needed.
4. Obtain a whole growing wheat plant with a number of leaves. Draw a diagram and label fibrous roots, root hairs, stem, leaf and tillers (side-shoots).

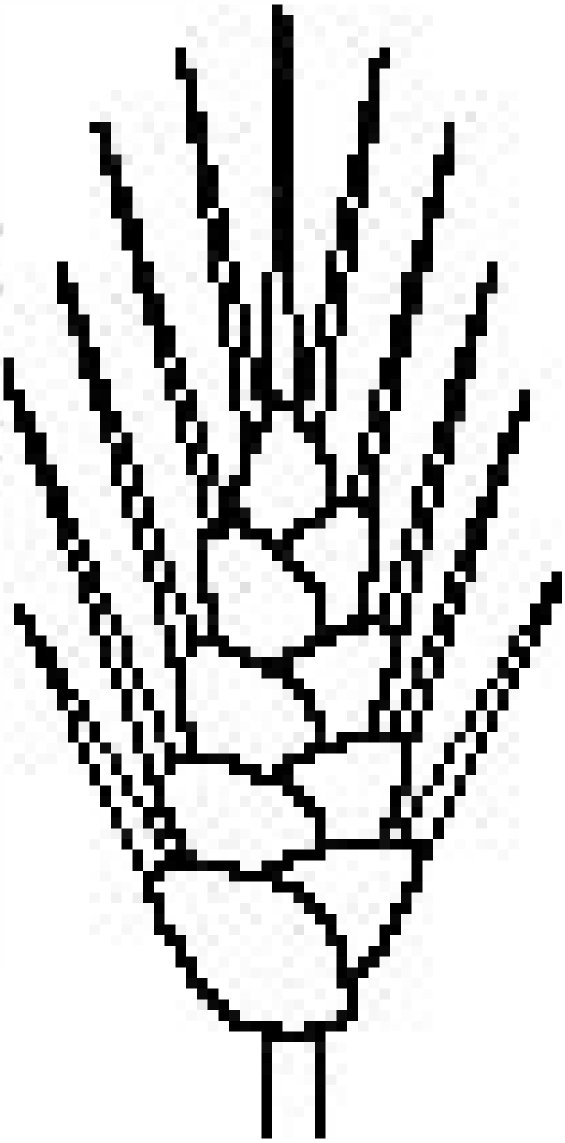
   Look carefully through a magnifying glass at where a leaf is attached to a stem, draw an enlarged diagram and label hollow stem, leaf sheath (around the stem), leaf blade, collar, auricle and ligule. These parts are important in identifying different types of grasses.

   On your diagram, sketch some veins in a leaf and label them parallel veins. Veins carry the water from the roots to the leaves, and the sap away from the leaves to the stem, roots, and growing parts.

   Using some clear sticky tape, place it firmly on the surface of the leaf to get an imprint, then remove it carefully and stick it on your page. Look at it under the magnifying glass or microscope to find stomata, or holes in the leaf surface where air enters and water evaporates.
5. Obtain a flowering wheat plant (or the flower head), draw a diagram and label the spike or ear with its separate spikelets.

   Gently separate a spikelet away, then open it to show that it contains little flowers called florets surrounded by protective covers called bracts or glumes. Look carefully with the magnifying glass to see that in each floret there are three male stamens containing pollen, and 1 female stigma with 2 feathery projections to catch the pollen. Wheat usually fertilises itself, but pollen blown on the wind can also help. Pollen fertilises the ovary at the base of the stigma to form a new seed. Try to draw and label 1 floret.

6. Obtain a mature ear of wheat with seeds, draw it and label ear, spike, bracts, seed. Separate out 1 grain by breaking its stalk (rachilla), and gently separate the seed from its protective bracts. Some wheat bracts have long awns. Think about how harvesting machinery has to separate out the seeds from the stems, leaves, spikes and bracts.



Student Activity 8

The growing wheat plant

Wheat starts growing from the food store in its seed. But it soon has to produce its own food so it keeps growing. How does it make food? How can we get it to grow faster?

Things to do

1a. 'Sow' some seed on wet cotton wool in 5 dishes, marked with your name. Place dish 1 in the dark, dish 2 in the refrigerator, dish 3 in a warm place in continuous light, and dish 4 in normal indoor conditions, near a window, where it won't be interfered with. Put dish 5 in a plastic bag, close it and leave it with dish 4. Check the dishes each few days to make sure they don't dry out.

1b. After 2 weeks measure and record the heights of the seedlings in each dish.

1c. Compare all the dishes with dish 4, and try to explain the results you received.

1d. Make a list of the resources that seeds need in order to germinate and grow.

1e. In any of the dishes are the seedlings all bent or leaning the same direction? Try to explain why they lean in that direction.

2a. Cut your initials out of a piece of aluminium foil. Go outside and wrap a soft plant leaf in the foil so your cut-out initials face the sun, but light only hits the leaf where your initials have been cut out. Stick the initials you cut out on another soft leaf with clear tape so they are in the sun. Leave it set up until at least the next day.

2b. Next class, pick your leaves, and another leaf you haven't covered at all. Put all three leaves in the boiling methylated spirits your teacher is heating in a water bath, in the fume cupboard. Leave them until the green colour (chlorophyll) comes out into the spirits. Remove the leaves, wash them in cold water, and then place them in iodine solution until you see your initials appearing. Wash them again. Let them dry, then stick them in your notes.

2c. Iodine solution turns starch black. For each of your leaves draw a picture showing where starch seems to be, or use labels for the leaves you stuck on the page.

2d. Explain where the starch comes from – what made it, if light is needed for it to be made, and the name of the process in leaves that makes starch. Why is this process important to plants? Why is it important to people?

3a. Go outside and wrap another leaf or group of leaves in a plastic bag with the bag closed, and leave it for at least a day.

3b. Look at the leaves in the plastic bag, and write down what you can see. Remove the bag so the leaves can live.

3c. What was in the plastic bag? Where did it come from? Why is it important to plants? Why is it important to people?

1. Check your answer to question 1d. Make a list of the resources that you think are important for <u>plants</u>, so they can grow, mature and produce seeds.

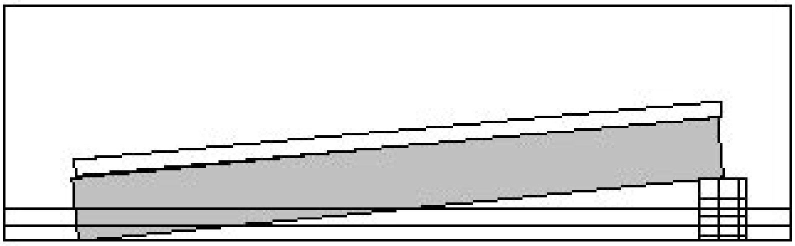
Student Activity 9

Conditions for growing wheat

In order to make most money from grain-growing, we need plants to produce lots of seeds. What conditions help the plant grow and produce more seeds?

Things to do

1. Collect used seedling trays from gardeners and nurseries, clean them and wash them in disinfecting solution.
2. Fill the trays with potting soil mix, nearly up to the groove.
3. Sow about 20 of your wheat seeds in the potting mix and cover them lightly with more potting mix.
4. Put your seedling trays into water in waterproof tubs or containers so the trays are on a slope, with one end saturated, the other end held out of the water.



5. Put 1 tub in a sheltered, shady, cool place. Put another in a sunny, warm place. Enclose another in a large clear plastic bag, and put it in the same warm sunny place. Measure the temperature of each tub for a week to find an average temperature, or use maximum/minimum thermometers.
6. Top up the water level every few days.

Each week look carefully at how the plants are growing in each tray (making notes if required), and answer these questions:

a. which plants grew the most?

b. which plants grew the least?

c. what happened to the plants at the lower end of the seedling tray? Why?

d. what happened to the plants at the top end of the tray? Why?

e. did the plants in the cool shady place grower better than those in warm sunny area? Why or why not? Think of as many reasons as you can for this to happen.

f. what happened to the plants in the plastic bag? Why do you think this happened?

g. think of as many reasons as you can why some plants in the paddock grow much.

h. say how these reasons can affect crop growing, knowing that farmers have little control over the climate (rainfall, temperature, etc.). That is, how can farmers plant their crops so they get the best growth rates?

Extensions

Measure to find the average growth of the plants in various conditions, so conditions can be compared quantitatively.

Keep different levels of water in different tubs to find if this changes the results. (Sloping seedling trays also allow comparison of plant height with distance from free water, and may allow a comparison of growth under different 'wetness' conditions.)

Use different soils (possibly from student properties) to compare growth rates. Students could compare growth rates in sand, sandy loam, clay loam and clay soils.

Use water of different qualities (possibly from student properties) for comparison.

Use different varieties of wheat to compare growth rates under varying conditions.

Students design their own experiment to find factors affecting wheat growth rates.

Extend the experiment for many weeks to find further effects.

Student Activity 10

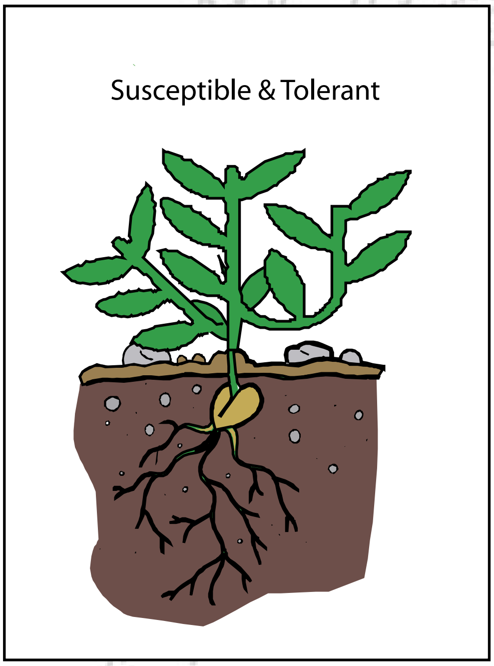
Alternative A – Nutrients needed for wheat

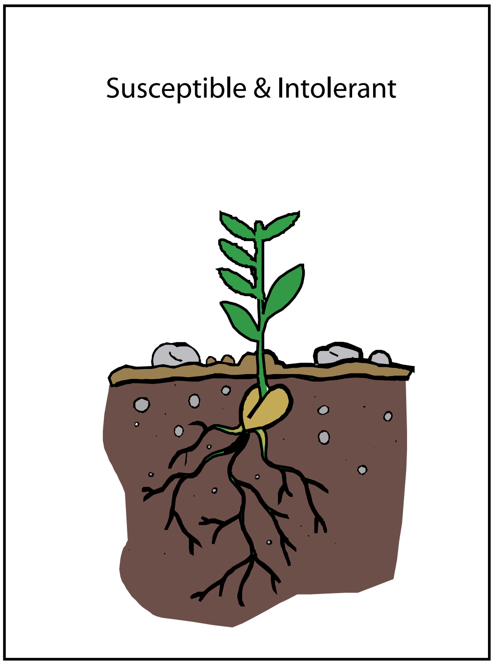
Australian soils are very old. Most of them are derived from the weathering of rock formed millions of years ago. This long period of leaching and exposure results in loss of most of the important plant nutrients. Wheat was first grown in Sydney on the site of the Sydney Botanic Gardens. The poor soil resulted in crop failure.

Wheat requires a reasonably fertile soil, with not too much acidity. It is very sensitive to nutrient shortages in early stages of growth. In general, phosphorus and nitrogen are deficient in Australian soils and are supplied by fertilisers. The nutrients in the soil affect how well the plant grows, and the quality of the grain produced. In some cases there is too much of a particular substance or nutrient in the soil such as boron, aluminium, manganese or salt, and this reduces plant growth. This is known as toxicity.

Different plant varieties grow better under different nutrient conditions. Some varieties can continue to grow and produce well when nutrients are lacking, or even become toxic. The Grains Innovation Park at Horsham breeds, tests and produces many different plant varieties for particular conditions.

Things to do





Read the following Grains Innovation Park experiment and use it to discuss how you could develop your own tests for nutrient deficiency or nutrient toxicity.

Boron toxicity testing

Aim

To find which wheat varieties are most tolerant to boron toxicity during germination and early growth, by comparing with growth in distilled water.

Materials

Different varieties of wheat seed including Frame (moderately tolerant) and Meering (intolerant) as controls, distilled water, boron solution, filter paper, aluminium foil, waterproof containers such as plastic tubs, buckets or beakers, plastic bags to cover samples.

Method

1. Label the outside of each filter paper with the names of the varieties used. Normally 8 seeds of each of 2 varieties are used, together with seeds of the controls, for each paper.
2. Fold the paper for a mark, or rule a line on the inside of the paper where seeds are to be placed.
3. Soak 1 paper in boron solution, place the seeds on the line with embryo down (round end down), roll the paper carefully (so the seeds aren't moved) and roll foil around it. Secure with an elastic band if needed. Then place the roll into a container with some boron solution. Repeat with other seed varieties. Cover each container with a plastic bag to reduce evaporation, and a black bag if it is left in the light. Keep at 12 to 15^{0}C.
4. Soak another paper in distilled water, place the same seed varieties along a line, roll up the paper and cover with foil. Place into a container with some distilled water. Repeat with other seed varieties. Cover with a plastic bag to prevent evaporation, and black bag where necessary to prevent light entering. Keep at 12 to 15^{0}C.
5. After 10 days unroll each paper and measure the root length of 4 of the seedlings.
6. If the other 4 seedlings are to be kept growing to measure coleoptile length, remove some foil to allow light to enter, and replace these in their containers with plastic bag coverings for 5 or more days at 150C.

Results

Extracted from actual results

Variety	Root Length In Boron mm				AV	Frame control
Babbler	32	16	16	17	20	43
Bowie	33	28	28	25	29	58
Chara	36	44	38	38	39	64
H45	36	38	36	38	37	12
RAC892	61	51	48	38	50	48
VM506	61	58	56	37	53	45
VO1226	58	38	34	30	40	32
VO1234	53	63	57	57	58	64
VO1832	69	57	56	48	58	63
VO2180	28	20	25	21	24	44
						Av 49

Boron tolerance of varieties is calculated relative to Frame, which is a moderately tolerant variety. Meering is also used as a relatively intolerant control.

To calculate % boron tolerance.

Babbler, av. root length in boron (20) is divided by av. root length in water (174) to give 0.115.

Compare this to Frame (49/201 = 0.244) by dividing Babbler 0.115 by Frame 0.244 to give Babbler a boron tolerance of 48%, which is called intolerant.

Variety	Root Length in Water mm				AV	Frame Control	Calculated Boron Tolerance %	Boron Tolerance
Babbler	173	172	174	177	174	206	48	Intolerant
Bowie	193	183	201	193	193	206	60	Intolerant
Chara	203	209	197	186	199	126	80	Mod intolerant
H45	183	167	177	168	174	171	87	Mod intolerant
RAC892	198	202	201	196	199	213	101	Mod tolerant
VM506	168	157	169	155	162	163	133	Mod tolerant
VO1226	203	187	183	172	186	202	88	Mod intolerant
VO1234	177	160	152	166	164	198	143	Tolerant
VO1832	187	166	163	168	171	201	137	Mod tolerant
VO2180	162	172	175	174	171	198	56	Intolerant
						Av 201		

For students to think about

- How can you use this system of growing seeds and seedlings in filter paper to test for nutrient deficiency instead of toxicity? What can you do that is the same? What must be changed?
- How do you make a solution deficient in one nutrient only?
- What nutrients would you test?
- What chemicals would you use? In what concentrations and mixtures?
- What factors do you need to keep constant for all seedlings, while you are comparing different nutrients?
- How would you know which seedlings lacked nutrients? What would you look for?
- How would you allow light to reach the developing seedlings?
- How long would you continue to grow the seedlings before you think the experiment is finished?
- What varieties of wheat would you use?
- How can you relate your results to situations on the farm?

Student Activity 10

Alternative B - Nutrients needed for wheat

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Wheat requires a reasonably fertile soil, with not too much acidity. It is very sensitive to nutrient shortages in early stages of growth. In general, phosphorus and nitrogen are deficient in Australian soils and are supplied by fertilisers. The nutrients in the soil affect how well the plant grows, and the quality of the grain produced. In some cases there is too much of a particular substance or nutrient in the soil such as boron, aluminium, manganese or salt, and this reduces plant growth. This is known as toxicity.

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Experiment

Aim

To investigate the effect of the presence or absence of certain chemical substances on the growth and development of a plant.

Procedure

1. Work in a group, and be personally responsible for one of the tests. Consult with your teacher, or with other members of your group, to decide which nutrient solution you will use. Mark your container appropriately.
2. Cut strips of black paper or foil wide enough to wrap around the glass containers, and fix these in position with tape to prevent light shining onto the seeds and into the solution below the growing plants.
3. Make up your nutrient solution by adding 1 mL from each of the appropriate chemical solutions. Then add 15 mL of distilled water to each container.
4. Label the paper with the name of the nutrient deficiency solution and seed varieties and fold or mark it to leave a horizontal line about 2 cm below the top. Dampen the paper with the correct solution, and then put seeds of each variety on the line with the embryo (round end) down. Carefully roll up the paper (making sure the seeds stay in position, maybe by using another piece of dampened paper over them) and place it in the nutrient deficiency solution. You need to exclude dust and reduce evaporation from your solutions, so cover them with plastic bags which have small holes for air transfer.

5. The cultures should be placed in bright light, but not where they become hot. Growth may be accelerated if the cultures are placed under continuous fluorescent light, but the seeds and roots (and solution) must be kept in the dark (under the foil or black paper). The best temperature is about 20^{0}C.
6. Once the plants have grown enough to compare properly (about 3 weeks depending on growth conditions) measure the amount of growth, and describe the colour of the leaves. Photographs may be used.

Results

Examine your results and compare growth in full nutrient solution with growth in each deficiency solution, and with growth in distilled water. Compare your results with data obtained by other groups. Suggest likely reasons for differences between your results and theirs.

You may wish to combine the data from other groups with yours, as they are all grown in similar conditions. Results (height of plants) may be graphed so comparison with different deficiency solutions is more visual. Put all the measurements on the same graph, using different colours for different nutrient deficiency solutions.

Questions

7. In which solution was greatest growth found?
8. What are the effects of complete absence of all nutrient elements?
9. Leaves contain chlorophylls – pigments which are dark green in colour – and also other pigments, which are yellow. Leaves which lack chlorophyll are yellow in colour. Was there less chlorophyll than normal in the leaves of any of the seedlings in this experiment? If so, which were these, and how do you explain the deficiency of chlorophyll in each case?
10. What were other deficiency effects on leaves?
11. What are the deficiency effects on the roots?
12. Are there any differences between different wheat varieties? What variety would you grow in your type of soil? Why?

Extensions

Continue the experiment for a longer period to find any further effects.

Try an alternative set-up such as that in Activity 9, but using vermiculite or other sterile medium that does not contain nutrients.

Do experiments in the field with different fertiliser applications. Farmer cooperatives like Birchip Cropping Group may help with information.

Try toxicity tests for manganese or aluminium, instead of the example with boron.

Student Activity 11

Effects of disease on wheat

All living things are affected by pests and disease. Crops are particularly susceptible because there is such a large area with the same plant growing in the same conditions, so any pests or disease that lives in those conditions will flourish.

We try and control pests and disease through good hygiene, by making conditions less suitable, by using natural predators, by chemical treatments, and by breeding. Sometimes we can breed plants that are less affected by a disease because they may be resistant to the disease (don't get the disease so easily), or because they are tolerant (can live satisfactorily with the disease). Susceptible plants are affected by the disease.

At Grains Innovation Park, Horsham there are many years of experience in breeding plant varieties that have greater resistance to particular diseases.

Use the following barley leaf rust experiment to design an experiment of your own, which tests different wheat varieties for their resistance to disease. Write up this experiment and discuss it with your teacher.

Experiment

Seedling resistance to spot form of net blotch (SFNB) in barley varieties

Objective

To determine the level of resistance to SFNB in the seedlings of various barley varieties, in order to help the plant breeder select more resistant/less susceptible varieties.

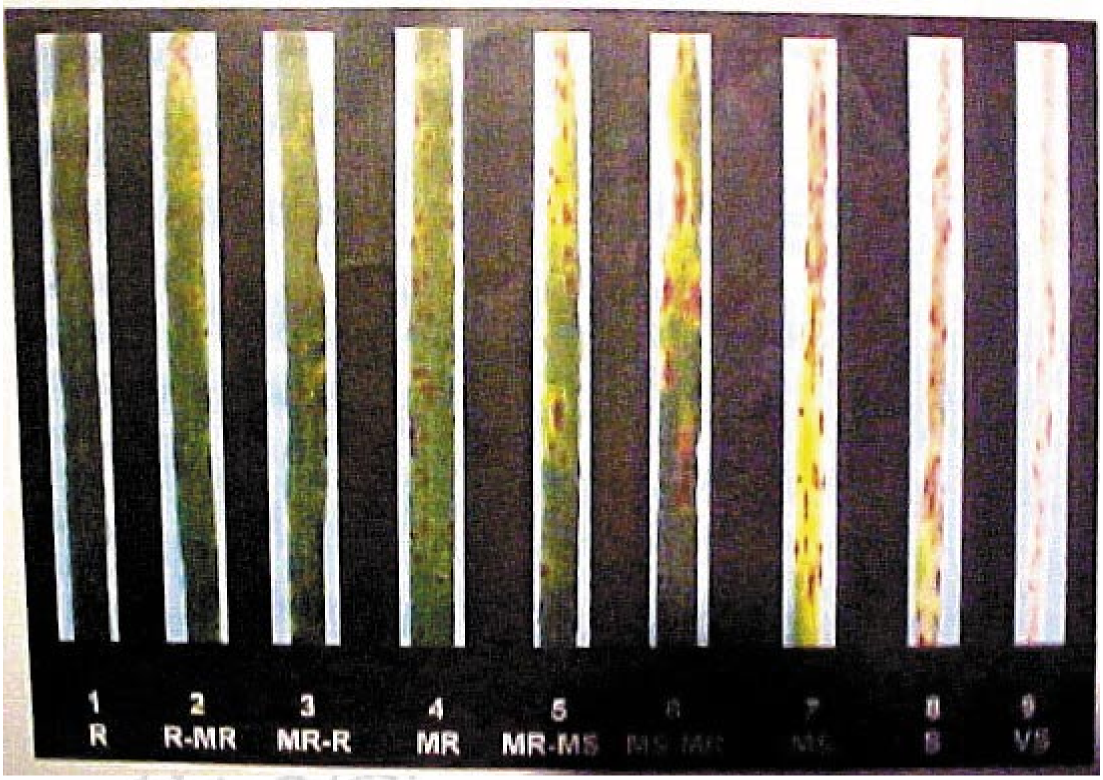
Overview

Various barley varieties are grown in pots. When they have 3 or 4 leaves, SFNB inoculum is applied to the seedlings. After 10 days the disease symptoms are rated on 1-9 scale according to severity. Four replicates are run in each experiment. Results are entered into a spreadsheet and analysed.

Method

1. Plant different barley varieties in labelled pots, 5 seeds per pot. Grow these in well-lit warm conditions with enough moisture, until they have 3 leaves (after 10 days in good conditions).
2. Collect old diseased barley leaves from crop residue, stubble or unharvested parts of the paddock, and place into a labelled plastic bag (adding some water for humidity) and store them in the refrigerator.
3. When the seedlings have 3 leaves, collect the bag of old diseased leaves. Add distilled water to the bag and agitate the leaves in the bag to remove the SFNB spores into the water. Leaves may be cut up into 1 cm lengths so spore lesions are cut through. Allow the leaves to settle or float and tip the SFNB spore water gently into a clean household squirter bottle, without extra leaf material.

4. Spray the 3-leaf barley seedlings thoroughly with the inoculum (spore water), then put the seedlings in a large plastic bag to maintain the humidity and place in the dark. After 24 hours put the seedlings in normal warm conditions in the light, maintaining the humidity.
5. After at least 8 days, using hand lenses, score (measure) the amount of rust on the barley leaves on a scale from 1 (resistant, with no rust) to 9 (very susceptible, covered in rust), by comparing with photographs. Collect, record and analyse the results for each variety.



Different responses to SFNB rust in barley, from resistant to susceptible

Results of susceptibility scores (test varieties and averaged controls) extracted from 60 actual results.

Variety	Replicate 1	Replicate 2	Replicate 3	Replicate 4	Mean Score
085B*014-003	7	7	7	6	7
100B*133-002	4	4	5	4	4
104B*083-001	3	3	3	3	3
100B*142-003	8	8	7	8	8
135B*007-001	4	4	4	4	4
Barque	3.25	5.00	3.00	3.00	3.5
Franklin	6.5	7.00	7.00	7.00	6.9
Keel	3.00	4.00	4.00	4.00	3.75
Schooner	4.00	6.00	5.00	5.00	5.0
Sloop	5.33	7.00	6.00	6.00	6.1

These results show that variety 104B*083-001 is the most resistant/least susceptible (score 3) of those tested, and 100B*142-003 is the least resistant/most susceptible (score 8).

By testing different varieties, researchers are able to select those varieties that are most resistant to a particular disease, and then breed from those. As disease organisms gradually adapt to their new environment (to new plant varieties), gradually causing more disease, so breeding for resistance is a continuous program. Resistant varieties also need to be combined with good crop management (hygiene, fungicides, etc) so that new disease populations don’t build up quickly.

Things to think about

- How can you use this system of collecting diseased plants to produce a fungus spray for testing different varieties? What can you do that is the same? What do you need to change?
- How can you compare diseased plants with each other to find which is most affected or least affected?
- What factors do you need to keep constant? What factors do you alter deliberately?
- What varieties of wheat would you use?
- Where can you obtain old or diseased wheat plants or parts of plants?
- How can relate your results in class to conditions on a farm? What would you be able to tell a farmer about wheat diseases and how to reduce the effects of disease?

Student Activity 12

Wheat breeding

Look around you at the other members of the class. Everyone is a human, in the species Homo sapiens, but we are all different. Wheat plants may all look the same to us, but they vary too.

Different varieties of wheat are grown for different purposes, and in different conditions. Our early settlers' crops near Sydney failed because they were using English varieties planted at the wrong time. Now we have a whole range of varieties grown for higher yield, better disease resistance, dryer conditions, better protein quality, etc.

In this activity we look at experiments conducted by Grains Innovation Park, Horsham, to test different plant varieties for some of their characteristics. Discuss these experiments with your teacher, and then design your own experiment to compare different varieties of wheat.

Experiment 1 – yield versus date of sowing

Over many years a number of wheat varieties have been sown in different areas on particular dates, in order to find the best sowing dates for each variety to give the highest yield.

One of the thousands of results shows that during the 1999 season, the variety 'Silverstar' yielded an average of 2.365 tonne/ha when planted on 27 May, 1.74 t/ha from 18 June, but only 1.553 t/ha when sown on 12 July.

Experiment 2 - time to emergence versus date of sowing

This experiment measures the average time it takes for seeds of the same variety to germinate and emerge through the soil after sowing, for particular dates of sowing. For successful production, all seeds need to germinate and grow well, and we need to know the best soil moisture and temperature in which to sow. This particular experiment has been completed for peas.

Emergence results (plants/m^2)

Sowing Date	Sowing Rate (kg/ha)	Dundale	Parafield	PSL4	Snowpeak
May 9	35	45	49	39	31
	55	50	60	54	37
	75	62	78	88	65
	100	123	98	95	72
June 16	35	44	39	53	45
	55	69	66	74	62
	75	92	83	102	88
	100	118	111	134	110
July 11	35	39	40	53	39
	55	51	62	64	56
	75	90	85	93	79
	100	103	117	124	112

However, remember that for high yields these emerging plants need to continue to grow, and produce seeds!

Experiment 3 – flour quality

Flour quality can vary greatly with the variety of wheat chosen. Student Activity 15 and the accompanying Fact Sheets have more details on different wheats and the different types of flour that are produced. But here are a few tests to check:

SDS sedimentation test

The SDS test is used by plant breeders to identify wheat varieties containing appropriate protein quality and quantity for baking. Each flour sample is placed into a measuring cylinder with 50 mL of distilled water; shaken by turning over 40 times; 50 mL of SDS solution added; shaken another 30 times; cylinder left standing and the volume of sediment in the bottom measured after 20 minutes. More sediment means more protein and 'stronger' dough.

Pelshenke test

This can be used to show the gluten protein content of flour samples. The longer the dough sample takes to disintegrate, the greater the protein content.

Flour samples are mixed into dough, and rolled into golf-ball sized balls. Each ball is placed into a beaker containing 80 mL of water at 30^{0}C, and the time measured until the ball starts to disintegrate (up to 7 hours for very strong hard wheat).

Baking test

This experiment compares bread-making characteristics.

Mix a 35 gm sample of flour with 4 gm of yeast in a bowl, add 220 mL warm water (40^{0}C), stirring, rolling into a ball. Knead for 10 minutes until smooth and elastic. 'Prove' in a warm oven for 30 minutes while the dough rises, then 'fold' it until it collapses, and shape it into a loaf in a greased baking tin. Cover and leave to 'prove' again. Bake in pre-heated oven at 220^{0}C for approximately 25-30 minutes (or you can use a 'bread-maker').

Things to think about

1. What are the most important characteristics of wheat for me to find out about? What's most important to me? What's important to my family?
2. How long do I have to complete the experiment? Will I try something lasting 20 minutes, or 20 weeks? Have I got time for a practice experiment to see how it works?
3. What experiments are best suited to this time of the year?
4. How many different types of wheat do I need to test?
5. What equipment will I need? Is it easy to get?
6. How can I try the experiment at home?
7. Where can I find out more about the experiment?
8. How do I make my experiment 'fair', so other people will believe my results?
9. In my experiment, what things do I have to keep the same, and what things do I have to change?
10. How many samples do I have to use before I can believe my results?
11. How do I manage the work and observations?
12. What do I need to measure? What do I need to record?
13. What type of report do I have to make?
14. How could I have improved my experiment? How can photos help my report?

Student Activity 13

Wheat farming

Being a farmer is often difficult. Farmers need to must make decisions constantly about best farming practices. Many farmers in the last 20 years have had to make decisions about whether to continue with conventional cultivation or adopt new 'minimum till' or 'conservation farming' practices.

The soils of the Wimmera region have about 1.3 million kilograms of soil per hectare in the top 100 mm. This valuable topsoil contains most of the nutrients and micro-organisms. Under conventional cultivation, soils are kept weed-free (bare) before sowing by regular cultivation, but it is estimated that approximately 1000 kg of topsoil is lost for every 1000 kg of grain produced. The soil is lost from the farm mostly due to wind and water erosion. This soil loss can also be much higher when we have severe droughts like in 1982 and more recently in 2003.

Being a farmer

This activity will help you study some of the decisions that farmers have to make.

Select a piece of ground about 60 cm by 30 cm in the school garden. Divide the ground into two equal parts to represent two paddocks.

One paddock will be conventionally cultivated. To do this dig the paddock up and then rake it a few times to get it smooth. You should have a nice tilth, not too many clods and no weeds.

The second paddock will be 'no-till', so the soil is to be disturbed as little as possible. Place straw or grass cuttings all over it to look like last year's stubble. The 'paddock' may have been sprayed beforehand to kill the weeds, but if there are any not sprayed, you may need to pull them carefully out, and lay them on top.

The next step is to make it look like a farm. Put in some roadways, and even small hills are good. You can use some toy farm-set pieces like little tractors, etc. Once you have developed your farm and you are happy with the way it looks, show your teacher.

Obtain some wheat seeds, and design a seeder to sow each of your paddocks. The seeding should be continuous, and you can't use your hands. An example could be a tube running down the back of a stick. Use the seeder to 'sow' your wheat.

Introduce some rain to your farm. With a watering can, quickly pour approximately 10 L of water through the 'spray' nozzle onto each of your paddocks (if you want to measure how much 'rain' this is, place a rain gauge on the edge of your farm first). Observe the effect of heavy rain on each of your farming systems.

Questions

1. Which farming system was easier to sow, and why?
2. Of your 2 farming systems, which do you think looked the best before the rain? Why?
3. What effect did the heavy rain have to each farming system? What caused the difference? Which system is better for the soil?
4. We looked at a heavy rainfall event, but what effect would strong winds have on each farming method? Which system would be best in a windy drought?
5. Which farming system would be easier to manage with the crop, in terms of spraying and harvesting?
6. If you were a farmer what farming method would you adopt, and why would you do this?

Extensions

Look up conservation farming on the Internet.

Look through a series of photographs of wheat farming operations, and put them in the correct order, as they would happen on the farm.

Student Activity 14

Wheat growing for profit

Farmers have many decisions to make about their property during the year. In this activity you are the farmer, making decisions about what types of production enterprises (wheat, sheep, barley, etc.) you are going to have in each paddock on your farm, for 6 years. Your goal is to get the greatest income, while improving your soil and reducing disease, and planning for drought and years of low income or low prices.

Gross margins are the $ returns per hectare, after costs of production have been subtracted, so they are the profits. The 2003/2004 Gross Margins ($/ha) for the Wimmera Mallee area have been used to make this activity realistic.

Longerenong College is a mixed farm in the Wimmera, Victoria. It has a mixture of self-mulching soils suitable for a variety of cropping and grazing activities. The farm is made up of a mixture of arable (can be cultivated) and non-arable areas. There is a drainage line that lies in the middle of the farm flooding a number of paddocks during wet years.

The photograph shows Longerenong Agricultural College, near Horsham in the Wimmera. The map shows how the paddocks are arranged, with the dotted line outlining the farm.

The gross margin per hectare will vary depending on the weather and price conditions. **Condition 1** represents the year 2003, with a late start to the season and good spring rainfall. Stock prices were high and wool prices low. Cereal prices were average, and grain legumes had low production because moist spring conditions limited bean and lentil yields due to disease.

To help you with planning your farm, actual gross margins ($/ha) in 2003/04 were:

Crop	GM ($/ha)	Crop	GM ($/ha)	Crop	GM ($/ha)	Crop	GM ($/ha)
irrigated lucerne	400	feed barley	347	beans	209	oats	255
first cross ewes	179	chickpeas	314	peas	271	lupins	145
oaten hay	377	cattle	106	canola	393	wethers	166
malt barley	356	lentils	367	vetch	193	wheat	311
prime lambs	246	triticale	315	SR merino	195		

You will need a separate farm production table (see below) for each year you play. Each year will have different weather conditions and prices, so each year produces a different set of results for each enterprise. You, as the farmer, must now choose which enterprises you will have in each paddock, for the first year.

When each farmer in your class has planned their year's production, the class draws one weather and price condition randomly from a 'hat'. Write this weather and price condition on your table. Then write down the correct gross margins for that weather and price condition, for each paddock and enterprise. Calculate your profit (or loss) for each paddock, and add these up to find your total profit or loss for that year.

You then plan another year, make another random draw of weather and price conditions, and again calculate your profit. Continue the game for 5 years, and then work out your total 5-year profit or loss.

There are rules that you need to use when planning each enterprise for each year, like the rules farmers must use. Your teacher will discuss these rules and may also vary conditions from time to time to simulate drought or low prices, like farmers might expect.

Answer these questions

1. Which was the most profitable enterprise over the 5 years? Why was it?
2. What affected your income most – the weather or the price? Explain, using examples.
3. Which enterprise would you try on your own farm? Why?
4. Why do different farmers grow different crops?
5. Would you use the same farm rules on your farm? How would you change them? Why?

Farm production Year...... Weather and price condition.........

Paddock Number	Paddock Size (ha)	Enterprise	Gross Margin ($/ha)	Profit/Loss
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
		Total production profit		

Condition 1. Late start to the season and good spring rainfall. Stock prices high and wool prices low. Cereal prices were average, and grain legumes (beans and lentils) had low yields because moist spring conditions favoured disease.

Condition 2. Good early rains allowed the establishment of most crops. Reduced winter rains and a dry spring reduced cereal yields and legume crops. Livestock prices remained good despite the dry conditions.

Condition 3. Late autumn rains ensure late sowing of all crops. Rainfall during early spring ensures rapid crop growth although hot dry conditions in October and November limit yields in legume and pulse crops whilst ensuring high protein in wheat. Wool, beef and lamb prices are depressed because of reduction in export quotas to America and Japan.

Condition 4. An early autumn break allows sowing of all crops, and pasture growth prior to winter. A mild winter leads to a reduction in supplementary feeding improving the profitability of all grazing enterprises. Extensive spring rains lead to waterlogging of most crops and some reduction of yields. Ascochyta blight in peas and chocolate spot in beans seriously reduces yields. A lot of pasture and some waterlogged crops are cut for hay. Prices for pulse and lentils are high because of failed crops in America and low yields in Australia. Canola prices are reduced due to excessive production in Canada

Condition 5. Extensive rain on Anzac Day ensures an excellent autumn break. Mild conditions from late winter and into spring ensured excellent crop establishment and growth. Cooler conditions during winter lead to extensive supplementary feeding of livestock and lower lambing and calving percentages. Much of the extra pasture is cut for hay. All prices of cereal, pulse and legume crops are high because of failed crops in America and Canada.

Weather Condition 6. Despite some early rain in March, this year has resulted in the majority of crops failing. Crops grown on fallow yield poorly, while other crops failed completely. Livestock prices rise as farmers purchase stock to eat crops. The Wimmera region is drought declared.

Condition 7. Excessively wet conditions hamper germination and lead to waterlogging of all crops and pastures. Cold wet conditions affect the profitability of grazing enterprises because of supplementary feeding and slow growth rates. Paddocks 11, 12, 13, 18 & 19 are flooded and unsuitable for cropping or grazing.

Farm Operating Rules

Fixed costs

A deduction of $4,500 is made each year to cover rates, water charges and maintenance of infrastructure.

Rotation Rules

All cereal crops must follow pasture, canola, legume or pulse crops.

Barley can follow cereal crops. A separate draw will determine if malting or feed quality is obtained.

Grazing enterprises can be repeated for 2 years before moving into a cropping phase.

All crops are usually changed every year. If crops are repeated there is a 20% reduction on the gross margins.

Irrigation

Lucerne may be grown in paddock 10 which has access to irrigation. Lucerne must be rotated every 2 years to prevent the build up of disease.

Cropping

Only 460 hectares of the farm may be cropped during any year because of restrictions on labour and machinery.

Flooding

Paddocks numbers 11, 12, 13, 18, 19 are prone to flooding which results in complete crop loss. This occurs for condition 7.

Likelihood of a particular condition occurring

Weather & price condition	Occurrences over 30 years
1	5
2	4
3	4
4	5
5	5
6	4
7	3

Student Activity 15

Wheat products

Bread is one of man's oldest and most diverse foods. Many types of flour and meal have been used to make it. Only the flour from wheat (and to a lesser degree from rye) can produce the type of dough needed for bread production.

The characteristics of bread made from wheat flour or wheat meal are directly attributable to the presence of gluten, the protein in flour.

Principles of dough preparation

Preparing dough for making bread involves adding water to a mixture of flour, salt, sugar, fat, and yeast. The water is absorbed, and gluten in the flour forms elastic films within the dough, trapping tiny gas pockets. Some of the gas is air trapped during mixing, and the rest is carbon dioxide released by yeast fermentation of dough sugars. Kneading, stretching and folding the dough helps improve its elastic properties and its ability to hold gas. Baking causes the expanded dough to set and become self-supporting, making a loaf.

Middle Eastern flat or pocket bread

There are many different baking techniques, although the basic steps are the same as for loaf bread. Some flat breads are hollow, the pocket forming naturally during baking under certain conditions. Before they are baked, the flattened pieces of dough are rested for a period under dry conditions so that both sides become slightly drier than the centre.

Noodles & pasta

Noodles and pasta are easily confused because they can look similar, but they are made in different ways. In making pasta, the dough is extruded through openings selected to produce a particular shape. Most commonly, pasta is dried and sold. Pasta is made from semolina or flour of high protein content, ideally of the durum type of wheat. Noodles are strips cut from rolled sheets of dough made from flour of medium to high protein content.

Biscuits, cakes & pastry

Biscuit doughs can be roughly categorised into two styles - crackers and hard sweet biscuits; and cookie and short sweet (shortbread) doughs. Soft flours are made from low protein wheat and strong flours from medium to high protein wheat. Low protein, soft wheat is also used to make cake flour.

Comparing different flour types by baking

This activity compares the bread making characteristics of three different 'flours' – bread flour, a mixture of equal quantities of bread flour and corn flour, and a mix of 75% bread flour and 25% wheat hearts (wheat germ).

The Recipe

Ingredients

350 gm (2 1/2 cups) of flour mix,

4 gm (1 1/2 tsp) of yeast,

220 mL of warm water (40^0C).

Method

- Separately make each type of flour mix into a dough by combining the flour and yeast in a bowl, then adding warm water and stirring into a rough dough ball.
- Knead each dough ball for 10 minutes with flour on your hands, and tip the dough onto a flat surface. Do this until the dough is smooth and elastic. Put the dough in a warm place (oven) for 30-40 minutes until it has risen (proved).
- Once the dough has risen, 'fold' it until it collapses. Then shape it into your desired loaf and place into a greased baking tin. Cover it and leave it to 'prove' again in the warm place (oven) until the dough has risen well above the tin (about 20 min). Bake in a pre-heated oven at 220^0C for 25-30 minutes until the loaf is golden brown. Cool the loaf on a wire rack.
- Or you could put your ingredients into a bread maker and let it do it all for you (but you might need to think about which program you choose!).

Questions

1. Describe the appearance of each of the 3 loaves (height, width, light/heavy, etc.).
2. Cut the loaves and describe the appearance of each (consistency, spring, strength, etc).
3. Taste the loaves and comment on any differences (softness, ease of eating, etc.).
4. Describe the texture (feel) of the three loaves.
5. Decide which bread contained most gluten, and which contained least, saying why you think so.
6. What might we use each type of flour for? Give reasons for your ideas.

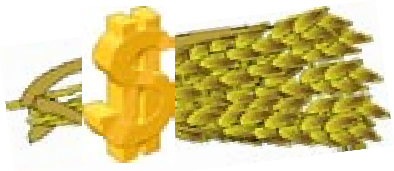
Extensions

Test other types of flour.

Work out the best flour mix to use in order to produce a 'survival biscuit', for supply to refugee camps.

Obtain fresh grain from different wheat varieties, and use these to compare the types of bread (loaf) they produce.

Student Activity 16



Turning Grain into Gold

Wheat and other grains are sown, fertilised, weeded, watered and grown to produce various types of food (and drink). This activity follows the path from seed through to food, from grain through growth and harvest through milling, refining and baking to a final product, turning Grain into Gold.

Things to do

1. Go through the following jumbled list of possible stages in the process of turning grain into gold (or money), and put them into a better sequence. Some processes may be used more than once, others not used at all.

Spraying weeds	Spraying pests	Sowing grain	Road transport
Rail transport	Harvesting	Testing quality	Milling grain
Storing grain	Preparing soil	Fertilising	Selling product
Packaging	Advertising	Storing product	Baking
Transport by boat	Air transport		

2. Collect a set of pictures that follow your sequence of turning grain into gold, and use these pictures to set up a display or presentation. The pictures may be photographs taken during previous activities, or while on farm and industry visits, or magazine pictures, or pictures downloaded from the Internet, or photocopies from books, and may also include wheat plants and seeds presented in previous activity displays.

   The display could be posters on the classroom wall, or set up on display boards, or could be presented as a PowerPoint slide show on computer (or projected), or you could make a video of the whole process.

   Each picture or part of the presentation needs to include some explanation, so that students from other classes can follow through the display or presentation and gain some of the understanding that you have gained during this unit.